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(54) **CURTAIN WALL INSULATION SYSTEM**

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CPC *E04B 2/96* (2013.01)

(58) **Field of Classification Search**
CPC E04B 2/96; E04B 1/7629; E04B 1/948; E04B 2001/389
See application file for complete search history.

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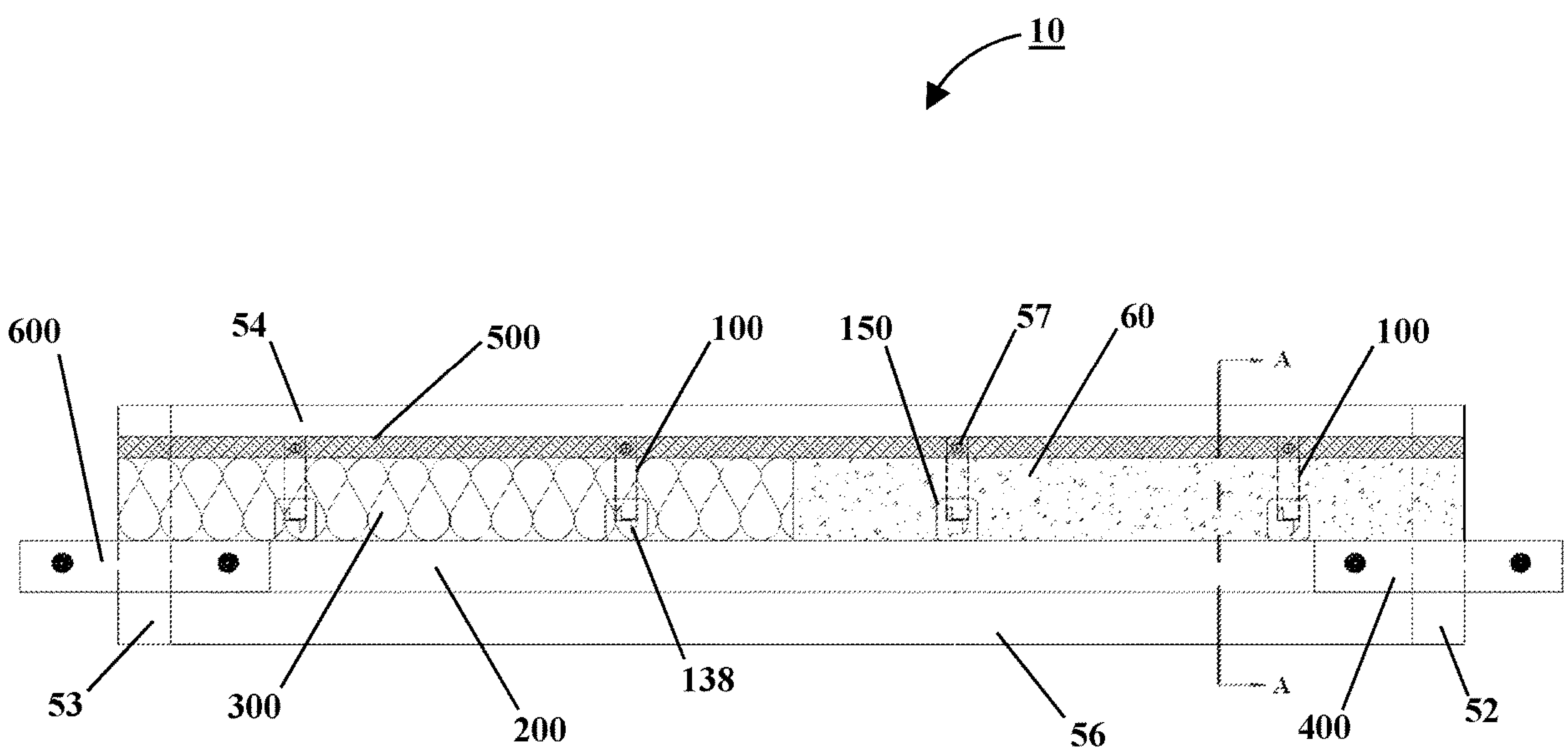
(57) **ABSTRACT**

A system for insulating a curtain wall structure is disclosed. The system includes a plurality of insulation hangers, a curtain wall insulation, and a safing insulation. The insulation hangers include a reinforcing member that engages a horizontal transom of the curtain wall structure. The system is attached only to horizontal transoms of the curtain wall structure via the insulation hangers to provide ease of installation and/or enhanced reliability.

20 Claims, 7 Drawing Sheets



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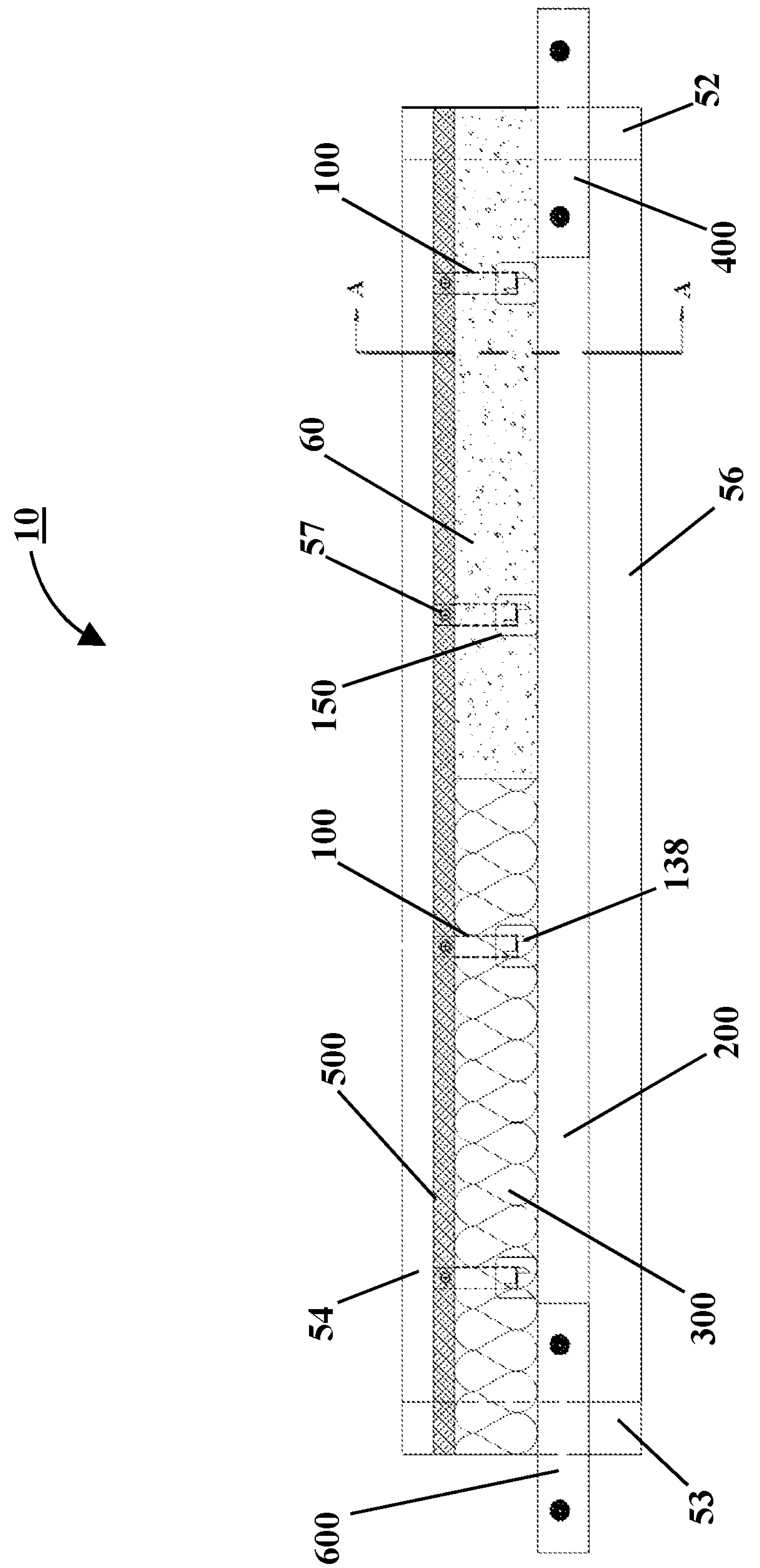

FIG. 1

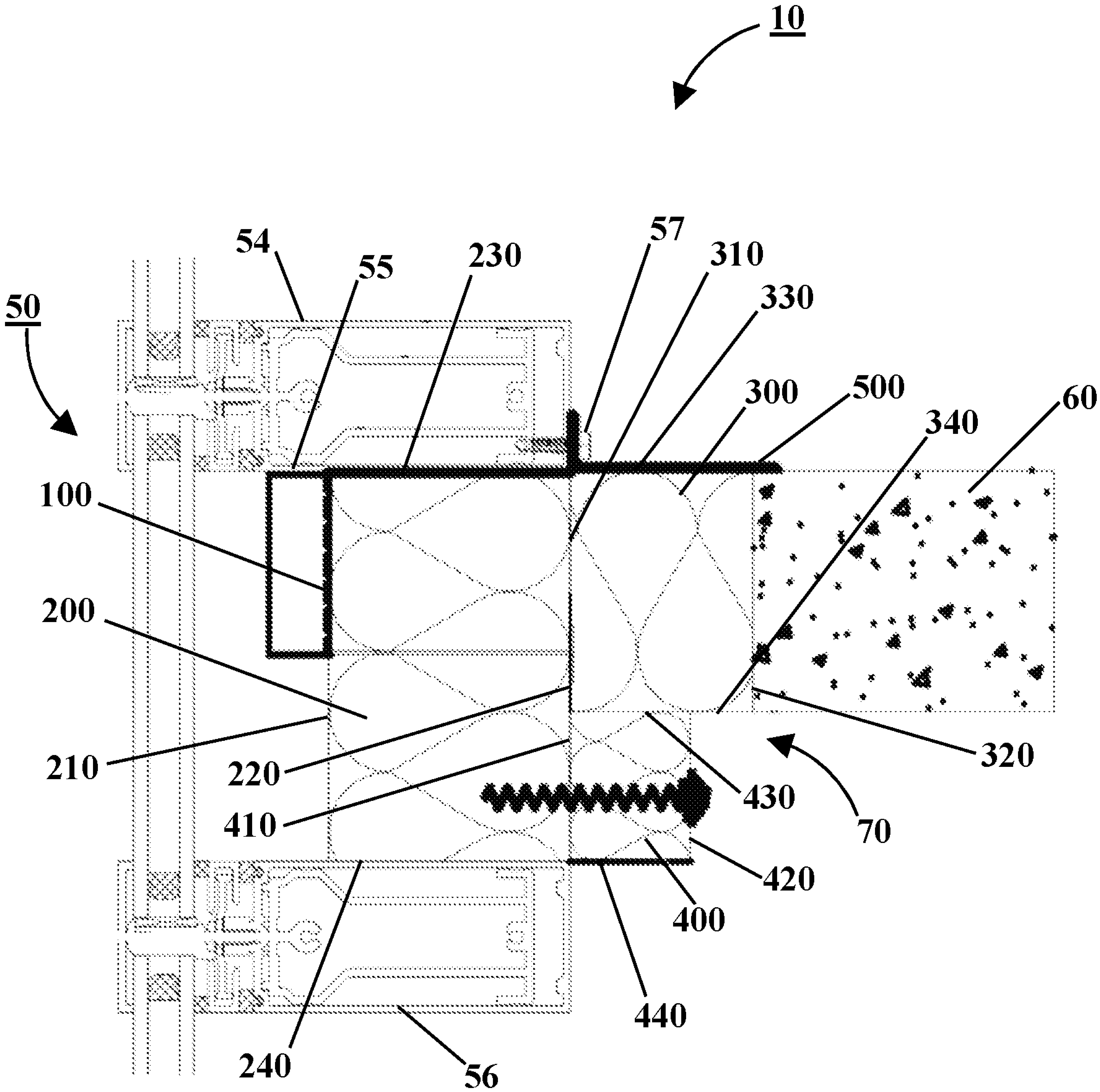
10
50
54
55
230
57
310
330
300
500
340
60
100
200
210
220
410
430
70
320
420
400
440
240
56

FIG. 1A

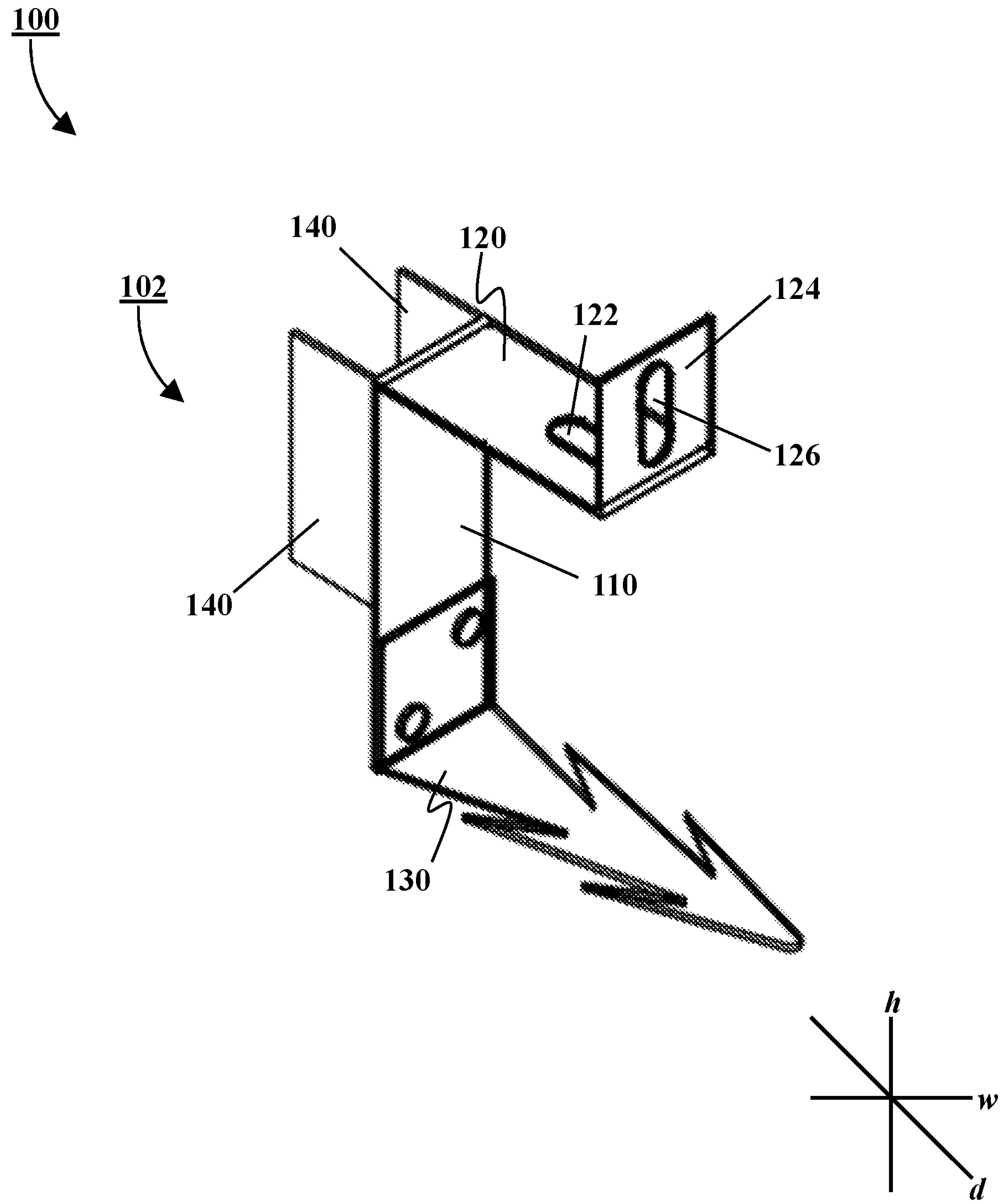

FIG. 2A

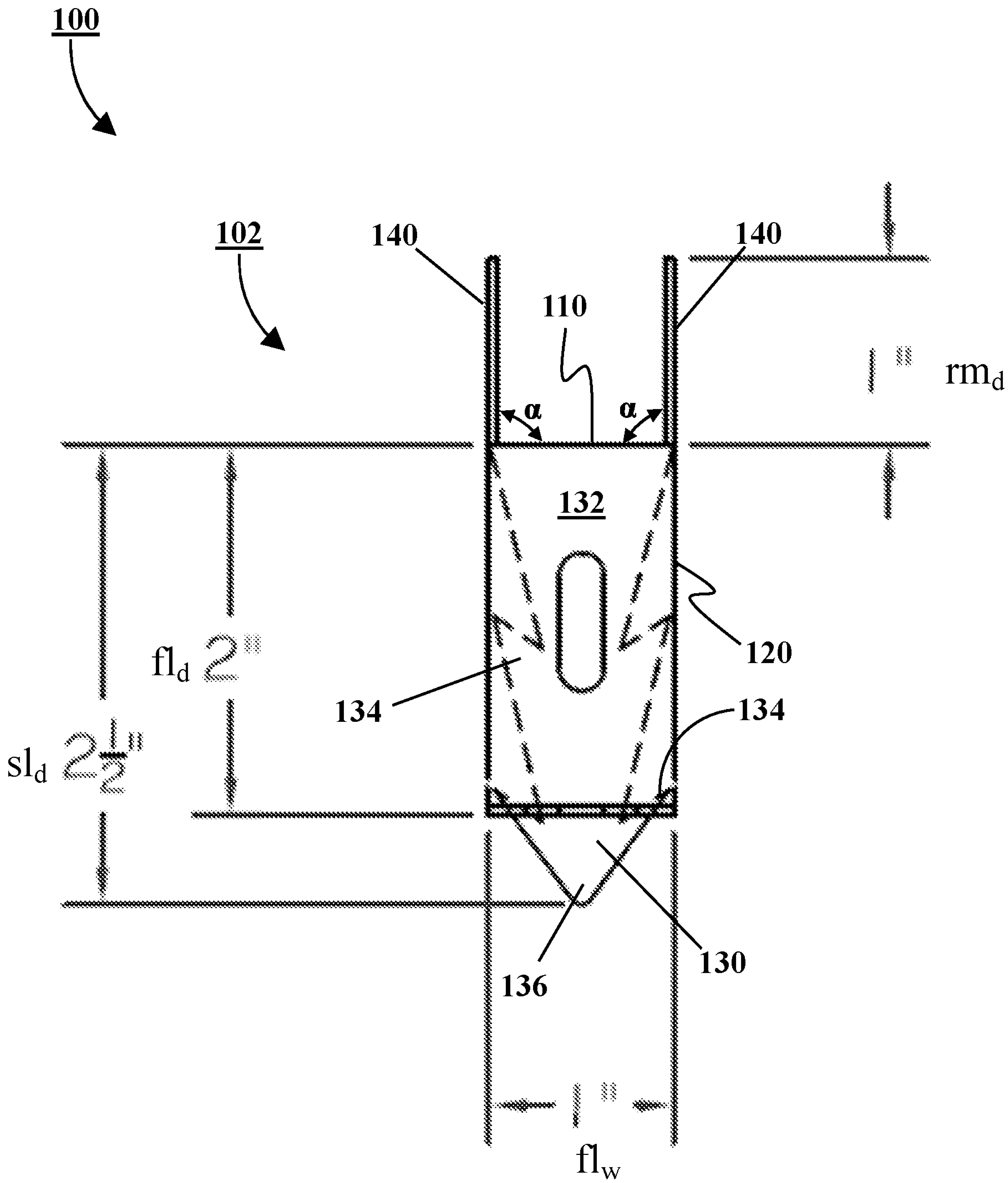
100
102
140
140
110
α
α
1"
rm_d
132
120
fl_d 2"
134
134
sl_d $2\frac{1}{2}$"
136
130
1"
fl_w

FIG. 2B

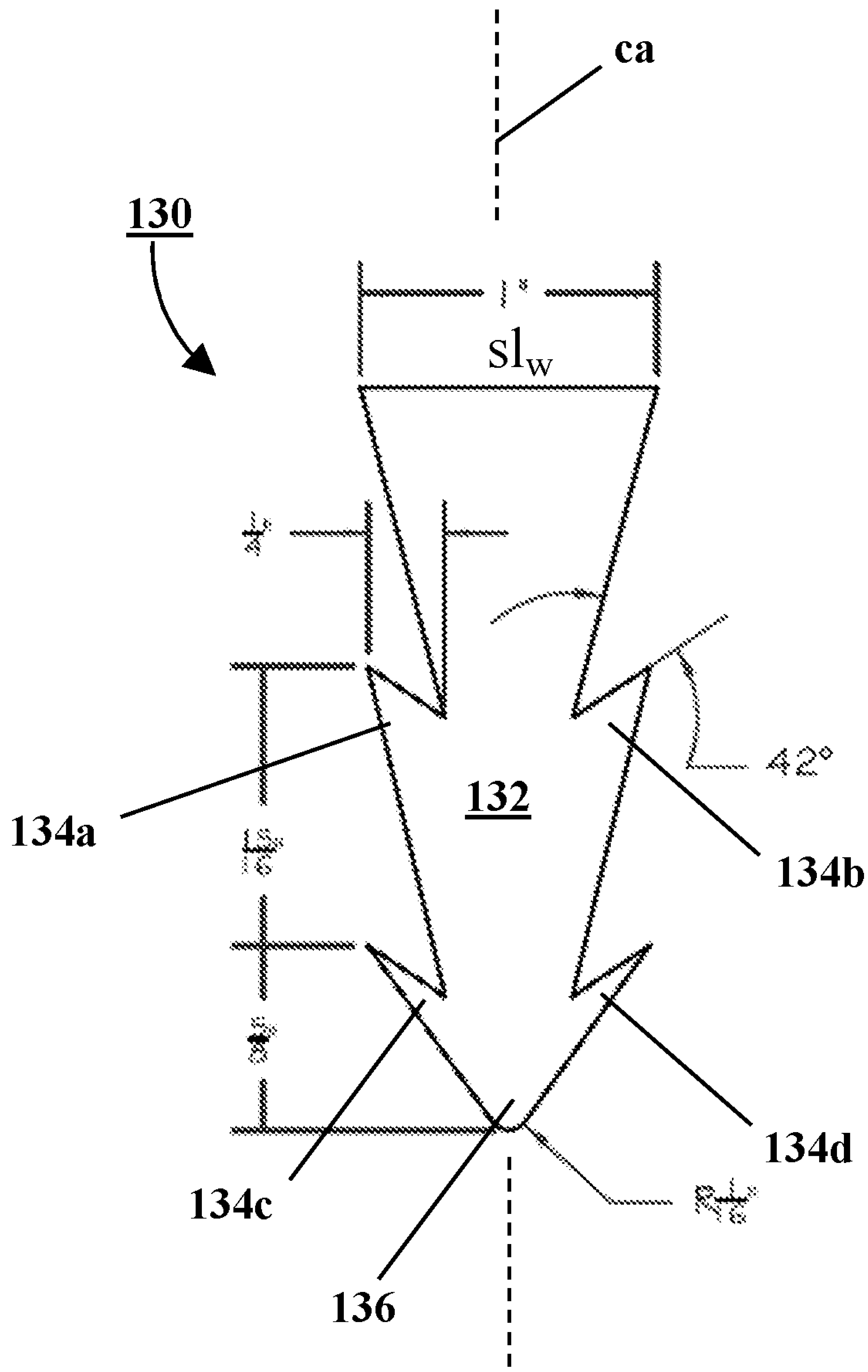

FIG. 2C

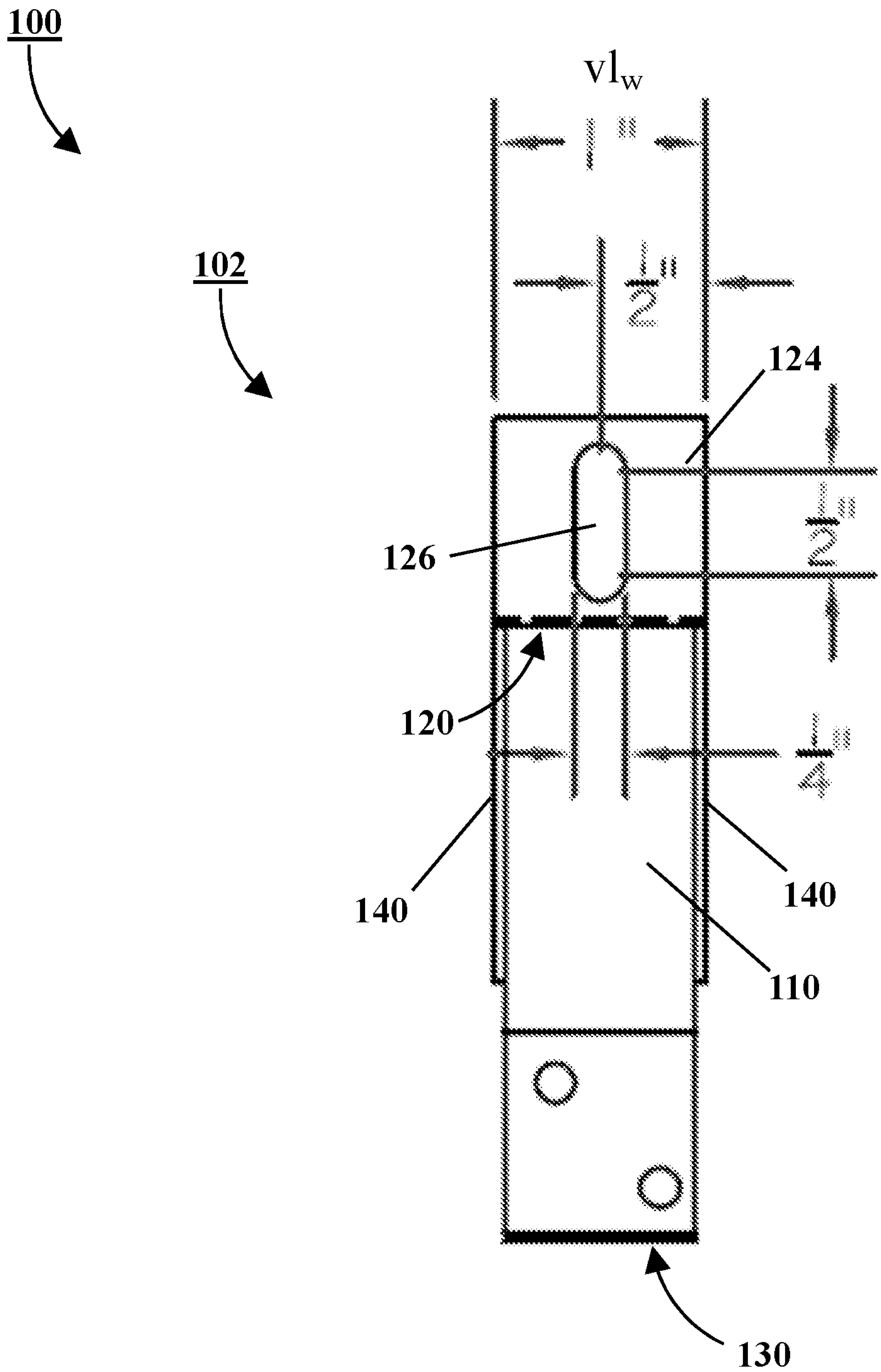

FIG. 2D

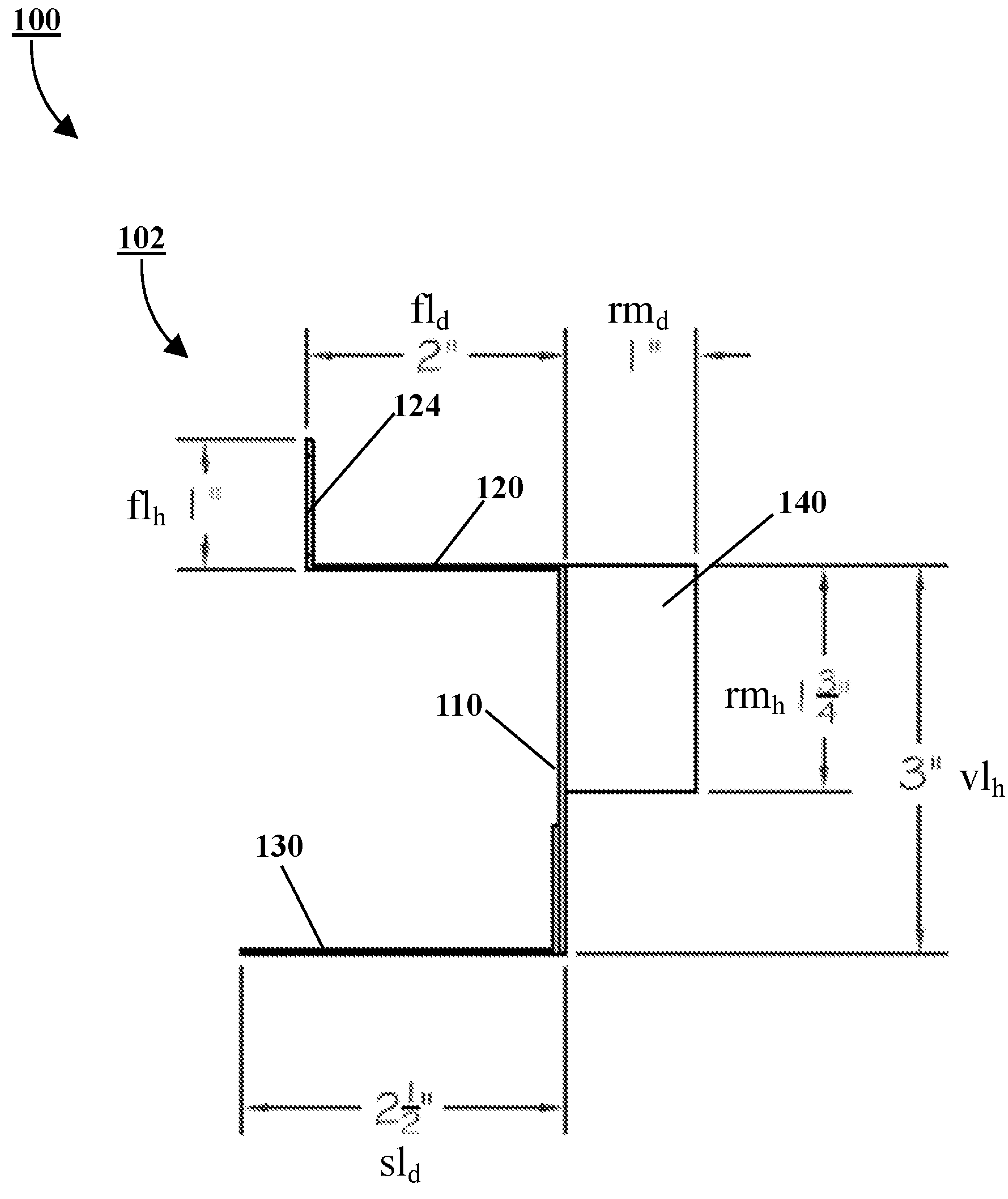

FIG. 2E

CURTAIN WALL INSULATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is the U.S. national stage entry of International Application No. PCT/US2021/029530, filed Apr. 28, 2021, which claims priority to and the benefit of U.S. Provisional Patent Application No. 63/132,862, filed Dec. 31, 2020, the entire disclosures of which are is incorporated herein by reference.

FIELD

The general inventive concepts relate to insulation systems for preventing a fire from moving between adjacent floors of a building and, more particularly, to a system for insulating a curtain wall structure that includes floor-to-ceiling glass, also referred to as a "zero spandrel" or "short spandrel" curtain wall structure.

BACKGROUND

High rise buildings are typically constructed with concrete floor slabs that "float" within an outer skin or curtain wall structure (i.e., windows and cladding materials interfaced with an aluminum framework). In other words, the curtain wall structure does not carry the load of the floors. The intersection of the curtain wall structure and the floor slabs creates a gap through which a fire on one floor may spread/climb vertically to floors above. Consequently, it is well known to insulate these gaps with fire-resistant materials to retard the spread of a fire from one floor to the next. This insulation takes the form of curtain wall insulation, safing insulation, and the like that fit in and around the framework (e.g., mullions and transoms) of the curtain wall structure. For example, U.S. Pat. No. 7,424,793, the entirety of which is incorporated herein by reference, describes a conventional curtain wall insulation system.

Many high rise building designs include curtain wall structures that feature floor-to-ceiling glass. These curtain wall structures are commonly referred to as zero spandrel or short spandrel curtain wall structures. In zero spandrel or short spandrel curtain wall structures, a bottom surface of a transom is positioned either at the same height as a top surface of the floor slab or a few inches (e.g., 3 inches) above the top surface of the floor slab. Some insulation systems for zero spandrel curtain wall structures utilize T-shaped backer bars and/or L-angles to secure and reinforce the curtain wall insulation. Other insulation systems for zero spandrel curtain wall structures utilize a galvanized steel pan that is attached to the mullions and a transom and is configured to retain the curtain wall insulation.

While conventional insulation systems for zero spandrel curtain wall structures are generally effective, the conventional insulation systems require transport and manual installation of many parts and pieces, which results in a relatively more difficult and lengthy installation. Moreover, conventional insulation systems that require attachment to the vertical mullions can prematurely fail in fire conditions due to the ability of a fire to travel inside the mullion and melt the mullion from the inside out. Furthermore, such conventional insulation systems when used in zero spandrel curtain wall structures are exponentially more likely to fail prematurely due to the smaller size of the vertical mullions used in such structures. Accordingly, there is an unmet need for an improved insulation system that requires transport and manual installation of fewer parts and pieces and that attaches only to a horizontally disposed transom of the curtain wall structure and, thus, can result in an easier installation, a reduced installation time, and a reduced chance of premature failure in fire conditions.

SUMMARY

The general inventive concepts relate to a system for insulating a curtain wall structure, particularly curtain wall structures that include floor-to-ceiling glass, which are commonly referred to as zero spandrel or short spandrel curtain wall structures. The system includes insulation hangers and curtain wall insulation that are configured such that no mechanical attachments to the vertical mullions of the curtain wall structure are made and separate reinforcing components (e.g., T-shaped backer bar) are not required. Accordingly, the system of the present disclosure can be installed easier and more quickly than conventional insulating systems, while also reducing the likelihood of premature failure in fire conditions.

In accordance with the present disclosure, a system for insulating a curtain wall structure connected to a building structure is provided. The curtain wall structure is spaced from a floor slab of the building structure to define a perimeter void. The curtain wall structure includes framing defined by at least first and second vertically disposed and parallel mullions, and a horizontally disposed transom. The system includes a plurality of insulation hangers. Each insulation hanger has a hanger body that includes a vertical leg, a first horizontal leg, a second horizontal leg, and at least one reinforcing member. The vertical leg extends between and connects the first horizontal leg and the second horizontal leg. The first horizontal leg and the second horizontal leg are parallel to one another and extend from the vertical leg in a first direction. The at least one reinforcing member extends from the vertical leg in a second direction. The first direction and the second direction are opposite of one another. The system also includes a curtain wall insulation having opposed outer and inner surfaces and opposed top and bottom surfaces, and a safing insulation having opposed outer and inner surfaces and opposed top and bottom surfaces. Each insulation hanger engages the curtain wall insulation such that the first horizontal leg abuts the top surface of the curtain wall insulation, the vertical leg abuts the outer surface of the curtain wall insulation, and the second horizontal leg passes through the outer surface of the curtain wall insulation and extends into the curtain wall insulation. Each insulation hanger is attached only to the horizontally disposed transom to secure the curtain wall insulation within the framing. The at least one reinforcing member of each insulation hanger engages a bottom surface of the horizontally disposed transom. The safing insulation is disposed within the perimeter void and compression fit between the curtain wall insulation and the floor slab.

In some embodiments of the present disclosure, the system includes a first mullion cover insulation having opposed outer and inner surfaces and opposed top and bottom surfaces. The first mullion cover insulation is attached to the curtain wall insulation such that the outer surface of the first mullion cover insulation abuts the inner surface of the curtain wall insulation, the top surface of the first mullion cover insulation abuts the bottom surface of the safing insulation, and the first mullion cover insulation covers a portion of the first mullion.

In some embodiments of the present disclosure, the system includes a smoke sealant applied to the top surface of the safing insulation.

In some embodiments of the present disclosure, the curtain wall insulation has a height of 6 inches to 9 inches, a depth of 3 inches to 6 inches, and a density of at least 4 lb/ft^3.

In some embodiments of the present disclosure, each insulation hanger is configured such that a height of the vertical leg is equal to a depth of the first horizontal leg and a depth of the second horizontal leg.

In some embodiments of the present disclosure, each insulation hanger is configured such that a depth of the vertical leg is equal to a height of the first horizontal leg and a height of the second horizontal leg.

In some embodiments of the present disclosure, each insulation hanger is configured such that the first horizontal leg is perpendicular to the vertical leg. In some embodiments of the present disclosure, each insulation hanger is configured such that the second horizontal leg is perpendicular to the vertical leg. In some embodiments of the present disclosure, each insulation hanger is configured such that both the first horizontal leg and the second horizontal leg are perpendicular to the vertical leg.

In some embodiments of the present disclosure, each insulation hanger is configured such that the at least one reinforcing member is perpendicular to the vertical leg. In some embodiments of the present disclosure, each insulation hanger is configured such that the at least one reinforcing member extends from the vertical leg at an angle in the range of 45° to 90°. In some embodiments of the present disclosure, each insulation hanger is configured such that the hanger body includes two reinforcing members spaced from one another by a distance that is less than or equal to a width of the vertical leg.

In some embodiments of the present disclosure, each insulation hanger is configured such that a height of the at least one reinforcing member is less than a height of the vertical leg. In some embodiments, each insulation hanger is configured such that a height of the at least one reinforcing member is equal to a height of the vertical leg. In some embodiments of the present disclosure, each insulation hanger is configured such that a height of the at least one reinforcing member is less than a height of the vertical leg and is greater than half of the height of the vertical leg.

In some embodiments of the present disclosure, each insulation hanger is configured such that the second horizontal leg includes a leg body having one or more barbs and a tapered end. In some embodiments of the present disclosure, each insulation hanger is configured such that the second horizontal leg is symmetrical about a central axis of the leg body. In some embodiments of the present disclosure, each insulation hanger is configured such that a depth of the second horizontal leg is less than a depth (i.e., thickness) of the curtain wall insulation.

In some embodiments of the present disclosure, each insulation hanger is configured such that the second horizontal leg includes a leg body having a pair of prongs configured to cooperate with a locking washer to retain the curtain wall insulation. In some embodiments of the present disclosure, each insulation hanger is configured such that a depth of the second horizontal leg is greater than a depth (i.e., thickness) of the curtain wall insulation.

In some embodiments of the present disclosure, each insulation hanger is configured such that the first horizontal leg includes a mounting flange that extends from and perpendicular to an end of the first horizontal leg. In some embodiments of the present disclosure, the mounting flange includes an aperture.

In some embodiments of the present disclosure, the hanger body of each insulation hanger is made of galvanized steel.

In embodiments of the present disclosure, the system does not include a reinforcement system at a safing line of the system other than the at least one reinforcing member of each insulation hanger. In embodiments of the present disclosure, the system does not include any mechanical attachments to the mullions.

Other aspects and features of the general inventive concepts will become more readily apparent to those of ordinary skill in the art upon review of the following description of various exemplary embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

The general inventive concepts, as well as embodiments and advantages thereof, are described below in greater detail, by way of example, with reference to the drawings in which:

FIG. **1** is a front elevation view of an embodiment of a system for insulating a curtain wall structure of the present disclosure.

FIG. **1**A is a cross sectional view of an embodiment of a system for insulating a curtain wall structure of the present disclosure taken along section line A-A of FIG. **1**.

FIGS. **2**A-**2**E illustrate an embodiment of an insulation hanger suitable for use in the system of the present disclosure. FIG. **2**A is a perspective view of the insulation hanger. FIG. **2**B is a plan view of the insulation hanger. FIG. **2**C is a detailed view of a second horizontal leg of the insulation hanger. FIG. **2**D is a front elevation view of the insulation hanger. FIG. **2**E is a side elevation view of the insulation hanger.

DETAILED DESCRIPTION

Several illustrative embodiments will be described in detail with the understanding that the present disclosure merely exemplifies the general inventive concepts. Embodiments encompassing the general inventive concepts may take various forms and the general inventive concepts are not intended to be limited to the specific embodiments described herein.

The general inventive concepts relate to systems for insulating a curtain wall structure connected to a building structure. The systems include innovative insulation hangers in combination with curtain wall insulation and safing insulation to effectively insulate a curtain wall structure, particularly a zero spandrel or short spandrel curtain wall structure. The insulation hangers and curtain wall insulation are configured such that no mechanical attachments to the vertical mullions of the curtain wall structure are made and separate reinforcing components (e.g., T-shaped backer bar) are not required. Accordingly, the system of the present disclosure can be installed easier and more quickly than conventional curtain wall insulating systems, while also reducing the chances of premature failure in fire conditions.

An embodiment of a system **10** for insulating a curtain wall structure **50** in accordance with the present disclosure is shown in FIGS. **1** and **1**A. The system **10** is useful for insulating a curtain wall structure **50** connected to a building structure (not shown), particularly zero spandrel or short spandrel curtain wall structures. As one of skill in the art will appreciate, a curtain wall structure **50** is a type of exterior wall system commonly used on buildings, such as high-rise buildings, wherein the curtain wall structure **50** does not bear the load of the building structure. As seen in FIG. **1**A, the curtain wall structure **50** is spaced from a floor slab **60** of the building structure to define a perimeter void **70**. The curtain wall structure **50** includes framing defined by at least first and second vertically disposed and parallel mullions **52**, **53**, and a horizontally disposed transom, such as an upper horizontally disposed transom **54** and a lower horizontally disposed transom **56**. Although FIGS. **1** and **1**A illustrate the framing as having both upper and lower horizontally disposed transom **54**, **56**, it is contemplated that the framing can omit the lower horizontally disposed transom **56** or include additional horizontally disposed transoms. The system **10** provides thermal insulation and also provides a barrier to inhibit the spread of fire from one floor of a building to an upper adjacent floor through the perimeter void **70**. The curtain wall structure **50** illustrated in FIGS. **1** and **1**A is exemplary of a zero spandrel curtain wall structure **50** where a bottom surface **55** of a horizontally disposed transom (e.g., upper horizontally disposed transom **54**) is positioned at the same height or level as a top surface of the floor slab **60**.

As seen in FIGS. **1** and **1**A, the system **10** includes a plurality of insulation hangers **100**, a curtain wall insulation **200**, and a safing insulation **300**. The insulation hangers **100** engage the curtain wall insulation **200** and secure the curtain wall insulation **200** within the framing defined by the mullions **52**, **53** and transoms **54**, **56**. The safing insulation **300** is disposed within the perimeter void **70** and compression fit between the curtain wall insulation **200** and the floor slab **60**. As shown in FIGS. **1** and **1**A, each insulation hanger **100** of the system **10** is attached only to the horizontally disposed transom **54** via a fastener **57** (e.g., a self-drilling, self-tapping screw). In other words, the system **10** does not utilize any mechanical attachments to the mullions to secure the curtain wall insulation **200** within the framing defined by the mullions **52**, **53** and transoms **54**, **56**. As previously mentioned, during a building fire, the fire can travel inside and up the mullions and melt the mullions from the inside out, and thereby melt any mechanical attachments to the mullions. By not utilizing mechanical attachments to the mullions **52**, **53**, the system **10** of the present disclosure is less likely to prematurely fail as compared to conventional curtain wall insulation systems that utilize mechanical attachments to the mullions.

Referring now to FIGS. **2**A-**2**E, an embodiment of an insulation hanger **100** of the system **10** of the present disclosure is shown. Although specific dimensions may be illustrated in some of the figures, the general inventive concepts are not limited to the disclosed dimensions.

The insulation hanger **100** includes a hanger body **102** that includes a vertical leg **110**, a first horizontal leg **120**, a second horizontal leg **130**, and at least one reinforcing member **140**. The hanger **100** can be made of any suitable material. In some embodiments, the hanger **100** is made of a metal including, but not limited to, steel, galvanized steel, brass, and aluminum. Ceramic materials may also be used to form the hanger **100**. In certain embodiments, the hanger **100** is formed of galvanized steel, and preferably 20 gauge galvanized steel.

As seen in FIG. **2**A, the vertical leg **110** extends between and connects the first horizontal leg **120** and the second horizontal leg **130** to one another. In some embodiments, a height vl_h of the vertical leg **110** is greater than a depth fid of the first horizontal leg **120** and a depth sl_d of the second horizontal leg **130**. In some embodiments, a height vl_h of the vertical leg **110** is equal to a depth fl_d of the first horizontal leg **120** and a depth sl_d of the second horizontal leg **130**. In some embodiments, a depth vl_d of the vertical leg **110** is equal to a height fl_h of the first horizontal leg **120** and a height sl_h of the second horizontal leg **130**. In some embodiments, a depth vl_d of the vertical leg **110** is equal to a height sl_h of the second horizontal leg **130** and is less than a height fl_h of the first horizontal leg **120**.

The first horizontal leg **120** extends from the vertical leg **110** in a first direction (e.g., forward of the vertical leg **110**), as seen in FIGS. **2**A and **2**E. In some embodiments, the first horizontal leg **120** is perpendicular to the vertical leg **110**. In some embodiments, the first horizontal leg **120** includes at least one aperture **122** therethrough to form a mounting hole. The hanger **100** may be mounted to the horizontally disposed transom **54** by passing a fastener (e.g., screw) through the at least one aperture **122** and into the horizontally disposed transom **54**. In some embodiments, the first horizontal leg **120** includes a mounting flange **124** that extends from and perpendicular to an end of the first horizontal leg **120**. In some embodiments, the first horizontal leg **120** is perpendicular to the vertical leg **110** and includes a mounting flange **124** that extends from an end of the first horizontal leg **120** and is parallel to the vertical leg **110**. In some embodiments, the mounting flange **124** includes an aperture **126** therethrough to form a mounting hole. In some embodiments, the aperture **126** extends through a depth fl_d of the first horizontal leg **120**. In some embodiments, the aperture **122** extends through a height fl_h of the first horizontal leg **120**. In some embodiments, the first horizontal leg **120** includes an aperture **122** that extends through a height fl_h of the first horizontal leg **120** and a mounting flange **124** having an aperture **126** that extends through a depth fl_d of the first horizontal leg **120**. In some embodiments, a depth fl_d of the first horizontal leg **120** is equal to a depth (i.e., thickness) of the curtain wall insulation **200**.

As seen in FIGS. **2**A and **2**E, the second horizontal leg **130** extends from the vertical leg **110** in the first direction (e.g., forward of the vertical leg **110**) and is parallel to the first horizontal leg **120**. In some embodiments, the second horizontal leg **130** is perpendicular to the vertical leg **110**. In some embodiments, a depth sl_d of the second horizontal leg **130** is less than a depth fl_d of the first horizontal leg **120**. In some embodiments, a depth sl_d of the second horizontal leg **130** is greater than a depth fl_d of the first horizontal leg **120**. In some embodiments, a depth sl_d of the second horizontal leg **130** is equal to a depth fl_d of the first horizontal leg **120**. In some embodiments, a height sl_h of the second horizontal leg **130** is equal to a height fl_h of the first horizontal leg **120** before the mounting flange **124**. In some embodiments, a height sl_h of the second horizontal leg **130** is less than a height fl_h of the first horizontal leg **120**.

As seen in FIGS. **2**B and **2**C, in some embodiments, the second horizontal leg **130** includes a leg body **132** having one or more barbs **134**. The leg body **132** includes a tapered end **136** beyond the barbs **134**. The tapered end **136** facilitates passage of the second horizontal leg **130** into a piece of insulation, while the barbs **134** are operable to hold/secure the insulation on the second horizontal leg **130**. In some embodiments, the second horizontal leg **130** includes a leg body **132** having a pair of prongs **138** (shown in FIG. **1**) that facilitate passage of the second horizontal leg **130** into a piece of insulation. The prongs **138** are configured to cooperate with a locking washer **150** (shown in FIG. **1**) (e.g., by passing the prongs through a slot of the locking washer **150** and then bending the prongs **138** in opposite directions) to secure the insulation on the second horizontal leg **130**. The leg body **132** of the second horizontal leg **130** may function as a shelf-like ledge operable to support the weight of the insulation.

In some embodiments, a depth sl_d of the second horizontal leg **130** is less than a depth (i.e., thickness) of the curtain wall insulation **200**. Accordingly, in some embodiments, the second horizontal leg **130** does not extend completely through the curtain wall insulation **200**, which maintains the integrity of a facing of the curtain wall insulation **200**, if present. In some embodiments, a depth sl_d of the second horizontal leg **130** is greater than a depth (i.e., thickness) of the curtain wall insulation **200**.

While the embodiment of the insulation hanger **100** illustrated in FIGS. **2A-2C** shows the same number of barbs **134** on each side of the leg body **132**, the general inventive concepts are not so limited. In some embodiments, one or more barbs **134** are only on one side of the leg body **132**. In some embodiments, the number of barbs **134** on one side of the leg body **132** differs from the number of barbs **134** on the other side of the leg body **132**. While the illustrated embodiment shows the second horizontal leg **130** to be symmetrical about a central axis ca, the general inventive concepts are not so limited. In some embodiments, the size, shape, and/or positions of the barbs **134** differ on opposite sides of the central axis ca of the leg body **132**.

As shown in FIG. **2C**, in one specific embodiment, the leg body **132** of the second horizontal leg **130** includes four distinct barbs, i.e., a first barb **134***a*, a second barb **134***b*, a third barb **134***c*, and a fourth barb **134***d*. A size, shape, and angle of the first barb **134***a* and the second barb **134***b* are the same. A size, shape, and angle of the third barb **134***c* and the fourth barb **134***d* are the same. In the embodiment illustrated in FIG. **2C**, at least one of the size, shape, and angle of the first and second barbs **134***a*, **134***b* is different from that of the third and fourth barbs **134***c*, **134***d*. In the embodiment illustrated in FIG. **2C**, the angle of at least the first and second barbs **134***a*, **134***b* is 42°±5°. The general inventive concepts contemplate that the barbs **134** can have any angle suitable to hold the insulation once it is impaled on the second horizontal leg **130**.

As mentioned above, the hanger body **102** includes at least one reinforcing member **140**. The at least one reinforcing member **140** extends from the vertical leg **110** in a second direction that is opposite of the first direction (e.g., rearward of the vertical leg **110**). In some embodiments, the at least one reinforcing member **140** is a flange. In some embodiments, the at least one reinforcing member **140** extends from the vertical leg **110** in a direction (or from a side) different and/or opposite than a direction (or side) that the first horizontal leg **120** and the second horizontal leg **130** extend from the vertical leg **110**. As seen in FIG. **2A**, each of the reinforcing members **140** extend along a height dimension of the vertical leg **110** and project outward along a depth dimension rearward of the vertical leg **110**, whereas the first horizontal leg **120** and the second horizontal leg **130** extend across a width dimension of the vertical leg **110** and project outward along a depth dimension forward of the vertical leg **110**. In other words, the at least reinforcing member **140** extends behind the vertical leg **110** and the first horizontal leg **120** and the second horizontal leg **130** extend in front of the vertical leg **110**. In some embodiments, the at least one reinforcing member **140** is perpendicular (i.e., angle α is to the vertical leg **110**, as seen in FIG. **2B**. In some embodiments, the at least one reinforcing member **140** extends from the vertical leg **110** at an angle α of less than or equal to such as at an angle α in the range of 45° to 90°.

In some embodiments, where there are two reinforcing members **140** extending from the vertical leg **110**, each reinforcing member may extend from the vertical leg **110** at an angle α of less than or equal to 90°, such as at an angle α in the range of 45° to 90°.

As shown in FIG. **2B**, in one specific embodiment, the hanger body **102** includes two reinforcing members **140** extending from and perpendicular to the vertical leg **110**. In this embodiment, the two reinforcing members **140** are spaced from one another by a distance that is less than or equal to a width vl_w of the vertical leg **110**. In this embodiment, the reinforcing members **140** have a rectangular shape. The general inventive concepts contemplate that the hanger body **102** can have additional reinforcing members **140** extending from the vertical leg **110** or a single reinforcing member **140** extending from the vertical leg **110**, preferably along a central axis of the vertical leg **110**. Furthermore, the general inventive concepts contemplate that the reinforcing member **140** can have any suitable shape, such as triangular, that allows the reinforcing member **140** to function as described herein.

In some embodiments, a height rm_h of the reinforcing member **140** is less than a height vl_h of the vertical leg **110**. In some embodiments, a height rm_h of the reinforcing member **140** is less than a height vl_h of the vertical leg **110**, a depth fl_d of the first horizontal leg **120**, and a depth sl_d of the second horizontal leg **130**. In some embodiments, a height rm_h of the reinforcing member **140** is equal to a height vl_h of the vertical leg **110**. In some embodiments, a height rm_h of the reinforcing member **140** is less than or equal to a height vl_h of the vertical leg **110** but greater than half of the height vl_h of the vertical leg **110** (i.e., $0.5vl_h \leq rm_h \leq vl_h$). In some embodiments, a height rm_h of the reinforcing member **140** is less than a depth fl_d of the first horizontal leg **120** but greater than half of the depth fl_d of the first horizontal leg **120** (i.e., $0.5fl_d < rm_h < fl_d$). In some embodiments, a height rm_h of the reinforcing member **140** is less than a depth sl_d of the second horizontal leg **130** but greater than half of the depth sl_d of the second horizontal leg **130** (i.e., $0.5sl_d < rm_h < sl_d$).

In some exemplary embodiments, a depth rm_d of the reinforcing member **140** is less than a height vl_h of the vertical leg **110**, a depth fl_d of the first horizontal leg **120**, and a depth sl_d of the second horizontal leg **130**. In some exemplary embodiments, a depth rm_d of the reinforcing member **140** is less than a height rm_h of the reinforcing member **140**. In some exemplary embodiments, a depth rm_d of the reinforcing member **140** is equal to a height rm_h of the reinforcing member **140**. In some exemplary embodiments, a depth rm_d of the reinforcing member **140** is less than or equal to half of a height vl_h of the vertical leg **110** (i.e., $rm_d < 0.5vl_h$). In some exemplary embodiments, a depth rm_d of the reinforcing member **140** is less than or equal to three-quarters of a depth fl_d of the first horizontal leg **120** (i.e., $rm_d < 0.75fl_d$). In some exemplary embodiments, a depth rm_d of the reinforcing member **140** is less than or equal to half of a depth sl_d of the second horizontal leg **130** (i.e., $rm_d < 0.5sl_d$).

The at least one reinforcing member **140** provides the hanger body **102** with greater structural integrity to resist deformation when acted on by external forces, particularly during a fire where a lot of turbulence, movement, and gravitational pull exists. In particular, the at least one reinforcing member **140** increases a depth of the insulation hanger **100** and provides at least one additional surface that engages or bears against a bottom surface **55** of the horizontally disposed transom **54**, as shown in FIG. **1A**, and thereby increases resistance to deformation by external forces exerted on the curtain wall insulation **200** due to the compression fit of the safing insulation **300** or by external forces caused by a fire. Accordingly, the insulation hangers **100** of the system **10** of the present disclosure having at least one reinforcing member **140** can prevent bowing or deformation of the curtain wall insulation **200** due to external forces, such as the compression fit of the safing insulation **300** or forces created during a fire, without the need for a separate reinforcement member (e.g., T-shaped backer bar) at or near a safing line of the system **10**.

Referring again to FIGS. **1** and **1**A, the system **10** of the present disclosure includes a curtain wall insulation **200**. As shown in FIG. **1**A, the curtain wall insulation **200** has opposed outer and inner surfaces **210**, **220** and opposed top and bottom surfaces **230**, **240**. The curtain wall insulation **200** may be formed of various materials based on a desired failure temperature of the material such as mineral wool. In certain embodiments, the curtain wall insulation **200** includes a facing (not shown) on an inner surface **220** thereof. The facing may be an aluminum foil or other suitable vapor retarder material. Such curtain wall insulation **200** is commercially available from Thermafiber, Inc. of Wabash, Indiana. The curtain wall insulation **200** used in the system **10** of the present disclosure may have a height of 6 inches to 12 inches (i.e., the distance separating the opposed top and bottom surfaces **230**, **240**), a depth (or thickness) of 3 inches to 6 inches (i.e., the distance separating the opposed outer and inner surfaces **210**, **220**), and a density of at least 4 pounds per cubic foot (lb/ft^3) (e.g., 4 lb/ft^3 to 14 lb/ft^3). In some embodiments, the curtain wall insulation **200** has a height of 6 inches to 12 inches, a depth of 3 inches to 6 inches, and a density of at least 6 lb/ft^3 (e.g., 6 lb/ft^3 to 14 lb/ft^3). In some aspects, the curtain wall insulation **200** has a height of 6 inches to 9 inches, a depth of 3 inches to 6 inches, and a density of at least 8 lb/ft^3 (e.g., 8 lb/ft^3 to 14 lb/ft^3). The curtain wall insulation **102** is disposed within the framing defined by the mullions **52**, **53** and transoms **54**, **56** and is mechanically attached via a plurality of insulation hangers **100** to the horizontally disposed transom **54**. Accordingly, the particular size and shape of the curtain wall insulation **200** will typically depend on the particular size and shape of the framing into which the curtain wall insulation **200** is being installed.

Due to its density (e.g., at least 4 lb/ft^3, or at least 6 lb/ft^3, or at least 8 lb/ft^3), the curtain wall insulation **200** is relatively rigid. The combination of the relatively rigid curtain wall insulation **200** with the insulation hangers **100** having at least one reinforcement member **140** and attached only to the horizontally disposed transom **54** provides the system **10** with sufficient reinforcement to resist deformation by external forces without requiring separate reinforcement members (e.g., T-shaped backer bars) or mechanical attachments to the vertical mullions **52**, **53**. Such design allows the system **10** to be installed easier and more quickly due to the presence of less parts/pieces and points of attachment.

With continued reference to FIGS. **1** and **1**A, the system **10** of the present disclosure also includes a safing insulation **300**. As seen in FIG. **1**A, the safing insulation **300** has opposed outer and inner surfaces **310**, **320** and opposed top and bottom surfaces **330**, **340**. The safing insulation **300** is disposed within the perimeter void **70** and compression fit between the curtain wall insulation **200** and the floor slab **60**. The safing insulation **300** inhibits flames and hot gases from moving from a first floor to an adjacent upper floor through the perimeter void **70**. As with the curtain wall insulation **200**, the safing insulation **300** may be formed of various materials based on a desired failure temperature of the material. In certain embodiments, the safing insulation **300** comprises mineral wool. The safing insulation **300** may have a depth (or thickness) of 1 inch to 8 inches, and a density of 4 lb/ft^3 to 8 lb/ft^3. Such safing insulation **300** is commercially available from Thermafiber, Inc. of Wabash, Indiana. When installed, the safing insulation **300** is commonly compressed to varying degrees, but normally it is compressed by at least 25% (i.e., compressed thickness of safing insulation is at least 25% less than original, uncompressed thickness). After installation, the safing insulation **300** provides a barrier to fire at the perimeter void **70**. Because the safing insulation **300** is compressed when installed, it provides some capability to expand which can seal openings or cracks that might otherwise develop in the perimeter void **70**. Slight variations in the size of the perimeter void due to expansion or other environmental changes are accommodated by the safing insulation **300** since it is compressed when placed in the perimeter void **70**, and thus can provide an effective seal under various conditions.

In certain embodiments, and as shown in FIGS. **1** and **1**A, the system **10** also includes a first mullion cover insulation **400** and a second mullion cover insulation **600** to cover and protect a portion of the first and second mullions **52**, **53** from hot flames and gasses during a fire. As seen in FIG. **1**A, the first mullion cover insulation **400** has opposed outer and inner surfaces **410**, **420** and opposed top and bottom surfaces **430**, **440** and is attached to the curtain wall insulation **200** such that the outer surface **410** of the first mullion cover insulation **400** abuts the inner surface **220** of the curtain wall insulation **200** and the top surface **430** of the first mullion cover insulation **400** abuts the bottom surface **340** of the safing insulation **300** and covers a portion of the first mullion **52** (as illustrated in FIG. **1**). The mullion cover insulation **400**, **600** may be attached to the curtain wall insulation **200** using fasteners (e.g., spiral anchors). Although not specifically illustrated, the second mullion cover insulation **600** is configured and installed in the same manner as the first mullion cover insulation **400** to cover and protect the second mullion **53**. The mullion cover insulation **400**, **600** may be formed of various materials based on a desired failure temperature of the material. In certain embodiments, the mullion cover insulation **400**, **600** comprises mineral wool. In certain embodiments, the mullion cover insulation **400**, **600** comprises mineral wool faced on an inner surface with an aluminum foil or other suitable fire resistant vapor retarder material. The mullion cover insulation **400**, **600** may have a thickness of 1 inch to 8 inches, and a density of 4 lb/ft^3 to 12 lb/ft^3. Such mullion cover insulation **400**, **600** is commercially available from Thermafiber, Inc. of Wabash, Indiana.

With continued reference to FIGS. **1** and **1**A, in certain embodiments, the system **10** includes a smoke sealant **500** applied to a top surface **330** of the safing insulation **300**. Any smoke sealant material known in the art may be utilized in the system **10** of the present disclosure. Exemplary smoke sealant materials suitable for use in the system **10** of the present disclosure include, but are not limited to, Fast Tack™ Firestop Spray or Series AS200 Elastomeric Spray smoke sealant, commercially available from Specified Technologies, (Somerville, New Jersey); Smoke Sealant Compound™ smoke sealant, commercially available from Thermafiber, Inc. (Wabash, Indiana); FireDam™ Spray 200 smoke sealant, commercially available from 3M (St. Paul, Minnesota); and TREMstop Acrylic SP smoke sealant, commercially available from Tremco Incorporated (Ashland, Ohio). The smoke sealant **500** provides a barrier to the passage of smoke and/or hot gasses through the safing insulation **300**. Further, in order to retard to the passage of smoke and/or hot gasses through the junctions between the sating insulation **300** and the curtain wall insulation **200**, as well as between the safing insulation **300** and the slab **60**, the smoke sealant **500** may be applied to extend from ½ inch to 1 inch onto both the curtain wall insulation **200** and the floor slab **60**, as shown in FIG. **1**A. Typically, the smoke sealant **500** is applied by spraying the smoke sealant material onto the top surface **330** of the sating insulation **300**.

The system **10** may be installed by interfacing the plurality of insulation hangers **100** with the horizontally disposed transom **54**. More specifically, the plurality of insulation hangers **100** may be secured to the horizontally disposed transom **54** via fasteners **57**, such as screws, such that the at least one reinforcing member **140** of each insulation hanger **100** engages or bears against the bottom surface **55** of the horizontally disposed transom **54**. After attaching the insulation hangers **100** to the horizontally disposed transom **54**, the curtain wall insulation **200** can be pressed onto the second horizontal leg **130** of each insulation hanger **100** such that the first horizontal leg **120** of each hanger **100** abuts the top surface **230** of the curtain wall insulation **200**, the vertical leg **110** of each hanger **100** abuts the outer surface **210** of the curtain wall insulation **200**, and the second horizontal leg **130** of each insulation hanger **100** passes through the outer surface **210** of the curtain wall insulation **200** and extends into the curtain wall insulation **200**. If insulation hangers **100** such as those depicted in FIGS. **2**A-**2**E are used, the installation of the insulation hangers **100** and curtain wall insulation **200** is complete. If insulation hangers **100** such as those depicted in FIGS. **1** and **1**A are used, the prongs **138** extend beyond the inner surface **220** of the curtain wall insulation **200** and the locking washer **150** is applied by passing the prongs **130** through a slot of the locking washer **150** and then bending the prongs **138** in opposite directions to retain the curtain wall insulation **200** on the insulation hanger **100**. Next, the safing insulation **300** is installed in the perimeter void **70** and compression fit between the inner surface **220** of the curtain wall insulation **200** and the floor slab **60**. The mullion cover insulation **400**, **600** may then be attached to the curtain wall insulation **200** via fasteners (e.g., spiral screws) such that the top surface of the mullion cover insulation **400**, **600** abuts the bottom surface **340** of the safing insulation **300** and covers a portion of the mullions **52**, **53**. A smoke sealant **500** may then be applied to the top surface **330** of the safing insulation **300**.

Alternatively, the system **10** may be installed by interfacing the insulation hangers **100** with the curtain wall insulation **200** prior to interfacing the insulation hangers **100** with the horizontally disposed mullion **54**. In particular, a plurality of insulation hangers **100** are interfaced with a portion of curtain wall insulation **200** sized to fit within the framing defined by the mullions **52**, **53** and the transoms **54**, **56**. More specifically, each insulation hanger **100** is pressed into the curtain wall insulation **200** so that the first horizontal leg **120** abuts the top surface **230** of the curtain wall insulation **200**, the vertical leg **110** abuts the outer surface **210** of the curtain wall insulation **200**, and the second horizontal leg **130** extends into the curtain wall insulation **200**. If insulation hangers **100** such as those depicted in FIGS. **2**A-**2**E are used, the barbs **134** on the second horizontal leg **130** effectively secure the curtain wall insulation **200** to the insulation hangers **100**. If insulation hangers **100** such as those depicted in FIGS. **1** and **1**A are used, the prongs **138** extend beyond the inner surface **220** of the curtain wall insulation **200** and the locking washer **150** is applied by passing the prongs **130** through a slot of the locking washer **150**, wherein the prongs **138** are then bent in opposite directions to retain the curtain wall insulation **200** on the insulation hanger **100**.

Thereafter, the curtain wall insulation **200** can be positioned and mounted within the framing of the curtain wall structure **50**. More specifically, fasteners **57**, such as screws, are used to secure the insulation hangers **100** to the horizontally disposed transom **54**. In this manner, the curtain wall insulation **200** is mechanically secured within the framing of the curtain wall structure **50**. Next, the safing insulation **300** is installed in the perimeter void **70** and compression fit between the inner surface **220** of the curtain wall insulation **200** and the floor slab **60**. The mullion cover insulation **400**, **600** may then be attached to the curtain wall insulation **200** via fasteners (e.g., spiral screws) such that the top surface of the mullion cover insulation **400**, **600** abuts the bottom surface **340** of the safing insulation **300** and covers a portion of the mullions **52**, **53**. A smoke sealant **500** may then be applied to the top surface **330** of the safing insulation **300**.

The terminology as set forth herein is for description of the embodiments only and should not be construed as limiting the disclosure as a whole. All references to singular characteristics or limitations of the present disclosure shall include the corresponding plural characteristic or limitation, and vice versa, unless otherwise specified or clearly implied to the contrary by the context in which the reference is made. Unless otherwise specified, "a," "an," "the," and "at least one" are used interchangeably. Furthermore, as used in the description and the appended claims, the singular forms "a," "an," and "the" are inclusive of their plural forms, unless the context clearly indicates otherwise.

To the extent that the term "includes" or "including" is used in the description or the claims, it is intended to be inclusive in a manner similar to the term "comprising" as that term is interpreted when employed as a transitional word in a claim. Furthermore, to the extent that the term "or" is employed (e.g., A or B) it is intended to mean "A or B or both." When the applicants intend to indicate "only A or B but not both" then the term "only A or B but not both" will be employed. Thus, use of the term "or" herein is the inclusive, and not the exclusive use. Furthermore, when the phrase "one or more of A and B" is employed it is intended to mean "only A, only B, or both A and B." Similarly, when the phrases "at least one of A, B, and C" or "at least one of A, B, C, and combinations thereof" are employed, they are intended to mean "only A, only B, only C, or any combination of A, B, and C" (e.g., A and B; B and C; A and C; A, B, and C).

The system of the present disclosure can comprise, consist of, or consist essentially of the essential elements of the disclosure as described herein, as well as any additional or optional element or feature described herein, or which is otherwise useful in curtain wall insulation applications.

All ranges and parameters, including but not limited to percentages, parts, and ratios, disclosed herein are understood to encompass any and all sub-ranges assumed and subsumed therein, and every number between the endpoints. For example, a stated range of "1 to 10" should be considered to include any and all sub-ranges beginning with a minimum value of 1 or more and ending with a maximum value of 10 or less (e.g., 1 to 6.1, or 2.3 to 9.4), and to each integer (1, 2, 3, 4, 5, 6, 7, 8, 9, and 10) contained within the range.

Unless otherwise indicated herein, all sub-embodiments and optional embodiments are respective sub-embodiments and optional embodiments to all embodiments described herein. While the present disclosure has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the present disclosure, in its broader aspects, is not limited to the specific details and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of applicant's general disclosure herein.

What is claimed is:

1. A system for insulating a curtain wall structure connected to a building structure, the curtain wall structure spaced from a floor slab of the building structure to define a perimeter void and the curtain wall structure having framing defined by at least first and second vertically disposed and parallel mullions, and a horizontally disposed transom, the system comprising:

- a plurality of insulation hangers, each insulation hanger having a hanger body that includes a vertical leg, a first horizontal leg, a second horizontal leg, and at least one reinforcing member, wherein the vertical leg extends between and connects the first horizontal leg and the second horizontal leg, wherein the first horizontal leg and the second horizontal leg are parallel to one another and extend from the vertical leg in a first direction, and wherein the at least one reinforcing member extends from the vertical leg in a second direction, the first direction and the second direction being opposite of one another;
- a curtain wall insulation having opposed outer and inner surfaces and opposed top and bottom surfaces; and
- a safing insulation having opposed outer and inner surfaces and opposed top and bottom surfaces;
- wherein each insulation hanger engages the curtain wall insulation such that the first horizontal leg abuts the top surface of the curtain wall insulation, the vertical leg abuts the outer surface of the curtain wall insulation, and the second horizontal leg passes through the outer surface of the curtain wall insulation and extends into the curtain wall insulation;
- wherein each insulation hanger is attached only to the horizontally disposed transom to secure the curtain wall insulation within the framing;
- wherein the at least one reinforcing member of each insulation hanger engages a bottom surface of the horizontally disposed transom; and
- wherein the safing insulation is disposed within the perimeter void and compression fit between the curtain wall insulation and the floor slab.

2. The system of claim **1**, further comprising a first mullion cover insulation having opposed outer and inner surfaces and opposed top and bottom surfaces, wherein the first mullion cover insulation is attached to the curtain wall insulation such that the outer surface of the first mullion cover insulation abuts the inner surface of the curtain wall insulation and the top surface of the first mullion cover insulation abuts the bottom surface of the safing insulation and the first mullion cover insulation covers a portion of the first mullion.

3. The system of claim **1**, wherein the curtain wall insulation has a height of 6 inches to 12 inches, a depth of 3 inches to 6 inches, and a density of at least 4 lb/ft^3.

4. The system of claim **1**, wherein a height of the vertical leg is equal to a depth of the first horizontal leg and a depth of the second horizontal leg.

5. The system of claim **1**, wherein a depth of the vertical leg is equal to a height of the first horizontal leg and a height of the second horizontal leg.

6. The system of claim **1**, wherein the first horizontal leg is perpendicular to the vertical leg.

7. The system of claim **1**, wherein the second horizontal leg is perpendicular to the vertical leg.

8. The system of claim **1**, wherein the at least one reinforcing member is perpendicular to the vertical leg.

9. The system of claim **1**, wherein the at least one reinforcing member extends from the vertical leg at an angle in the range of 45° to 90°.

10. The system of claim **1**, wherein a height of the at least one reinforcing member is less than a height of the vertical leg.

11. The system of claim **1**, wherein a height of the at least one reinforcing member is equal to a height of the vertical leg.

12. The system of claim **1**, wherein a height of the at least one reinforcing member is less than or equal to a height of the vertical leg and is greater than half of the height of the vertical leg.

13. The system of claim **1**, wherein the hanger body includes two reinforcing members spaced from one another by a distance that is less than or equal to a width of the vertical leg.

14. The system of claim **1**, wherein the second horizontal leg includes a leg body having one or more barbs and a tapered end.

15. The system of claim **14**, wherein the leg body includes a plurality of the barbs.

16. The system of claim **15**, wherein the leg body includes four of the barbs.

17. The system of claim **15**, wherein a number of the barbs on one side of the leg body differs from a number of the barbs on the opposite side of the leg body.

18. The system of claim **14**, wherein the second horizontal leg is symmetrical about a central axis of the leg body.

19. The system of claim **1**, wherein a depth of the second horizontal leg is less than a thickness of the curtain wall insulation.

20. The system of claim **1**, wherein the system does not include a reinforcement member at a safing line of the system other than the at least one reinforcing member of each insulation hanger.

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